Exhibit K – Part 1

Expert Report of Paul Horowitz on Invalidity of U.S. Patents No. 6,107,851, 6,229,366, and 6,249,876

I. Background and Scope of This Report

1. I have been asked by attorneys for Fairchild Semiconductor International, Inc. and Fairchild Semiconductor Corporation (collectively "Fairchild") to review U.S. Patents No. 6,107,851 ("Offline Converter with Integrated Softstart and Frequency Jitter"), No. 6,229,366 ("Off-line Converter with Integrated Softstart and Frequency Jitter"), and No. 6,249,876 ("Frequency Jittering Control for Varying the Switching Frequency of a Power Supply"), along with relevant portions of their prosecution histories, particularly with respect to accusations by Power Integrations, Inc. of infringement by Fairchild's switching converter products.

2. I have been asked to set down in this report my technical understanding of these patents, and where necessary, the understanding that one of skill in the relevant art would have had when reading them at the time they were filed.

3. I have been asked to review relevant qualifying prior art at the time of the patents, and to give my opinion as to the validity of the asserted claims of the respective patents, in light of the prior art.

4. In the following sections I have addressed these questions. I have organized the report as

II. Documents Reviewed
III. Qualifications and Prior Testimony; Compensation
IV. Person of Ordinary Skill
V. Summary of the '851, '366, and '876 Patents
VI. Summary of Relevant Prior Art
VII. Validity of the Asserted Claims

and I have numbered the paragraphs for ease of reference.

5. If asked at hearings or trial, I am prepared to explain in detail, with appropriate visual aids, the operation of the apparatus described in the '851, '366, and '876 patents. Such testimony may include appropriate background material on electronics and electronic circuits. I am also prepared to testify on matters raised in cross-examination; to rebut, as necessary, matters raised (in reports, depositions, and/or court testimony) by other experts; and to address other related matters raised at trial.

II. Documents Reviewed

6. In the preparation of this report, I have relied upon the following materials:

- the '851, '366, and '876 patents
- the prosecution history of these patents
- the Djenguerian, Go, Lund, and Balakrishnan[1] deposition transcripts
- datasheets, technical articles, and other documents listed in the Attachments
- Reference materials available in the late 1990's, including data sheets, application notes, textbooks[2], reference books, and trade journals[3]

III. Qualifications And Prior Testimony; Compensation

7. I am a Professor of Physics and of Electrical Engineering at Harvard University, where I teach courses in Physics and in Electronics, and where I perform and supervise experimental research. Additional career details can be found in the attached Curriculum Vitae.

8. My expertise in the field of electronics and computers includes some 40 years of electronic circuit design experience, which spans the time frame during which the '851, '366, and '876 patents were filed. In 1974 I originated an Electronics course at Harvard University, Physics 123, which continues to this day, and which is taught in the regular semester (in four classes, to accommodate the demand) as well as in Harvard's Extension school and Summer school. A set of notes written originally for the course in 1974 was expanded (with co-author Winfield Hill) and published as *The Art of Electronics* by Cambridge University Press in 1980.

9. That edition went through some 20 printings, adoptions by several technical book clubs, and translations into several languages, and it (and the companion *Laboratory Manual* co-authored with Ian Robinson) formed the basis for numerous copies of our electronics course; the textbook received much critical praise, and is generally accepted as an authoritative reference on electronic circuit design.[4] In 1989 an expanded second edition was published, again with co-author Hill, this time with an expanded *Student Manual* (with co-author Thomas Hayes). Translations of this edition have been published in German, French, Dutch, Chinese, Russian, Indonesian, and Polish, with additional foreign editions licensed or in progress. This

[1] Portions of the rough transcipt only.

[2] Particularly *Electronic Circuits*, by Tietze and Schenk (1990; 1978), and *The Art of Electronics*, by Horowitz and Hill (2e, 1989).

[3] Copies of selected citations are included in the Attachments.

[4] It has the distinction of being one of the three circuit design texts included in IEEE Spectrum's "Treasured Textbooks (1940–1980)" (*Spectrum*, **40**, 7 (2003)).

text/reference[5] covers electronics circuit design broadly, and in fact includes much of the technology disclosed in the '851, '366, and '876 patents. Chapter 6 of *The Art of Electronics* is titled "Voltage Regulators and Power Circuits," and includes both linear and switching power supplies and converters.

10. In addition to teaching the Electronics course, I supervise several graduate students whose work includes design and construction of electronic instrumentation. In that role, in addition to acting as informal consultant to other research groups at the University, I have designed numerous electronic circuits and instruments.

11. I also am the originator and co-supervisor of the Electronic Instrument Design Laboratory at Harvard University, run jointly by the department of Physics and the Division of Engineering and Applied Sciences. This laboratory provides circuit and instrument design, construction, and development services to research groups within the university.

12. Outside of my university duties I have designed electronic products for several commercial ventures. I have also led technical studies, and co-authored reports for various government entities as a member (since 1983) of a technical consulting group of academic scientists and technologists; these often involve issues of electronics in communications and instrumentation. In that role I have led some 20 technical studies, and coauthored over a hundred technical reports.

13. In my career I have designed and built literally hundreds of electronic circuits, broadly spanning the range from analog to digital, audio to radiofrequency, discrete to integrated to microprocessor. Over the years I have designed with vacuum tubes, transistors, and integrated circuits (from the earliest RTL logic to the sophisticated CMOS microprocessors and microcontrollers of today), for applications ranging from low-level signals, digital processing and computers, audio and communications, imaging, motion control, and mixed-signal. Incorporated within these are hundreds of power supplies, some of commercial design (linear and switching), and the rest of custom design. This design activity spans the time frame of the '851, '366, and '876 patents, at which time I had been teaching electronics at Harvard for over twenty years. Based upon this background, I believe I can speak with confidence about electronics from the viewpoint of a circuit designer in the 1997–2000 time frame.

14. During 1997 I testified by deposition and at trial in the case of *Security and Access v. Motorola, Inc.*[6], tried in the U.S. District Court for the District of Delaware. From July 1999 I have been serving as an expert witness[7] in several cases involving patents held by Vicor Corporation, in particular *Vicor v. Unitrode*, *Vicor v. Lucent*, *Vicor v. Power-One*, *Vicor v. Artesyn*, and *Vicor v. Lambda*. These are being tried in

[5] References to this volume will be called out as "H&H," its nickname, apparently, as used by practicing engineers.

[6] on behalf of Motorola.

[7] on behalf of Vicor.

the U.S. District Court for the District of Massachusetts; my participation has taken the form of Expert Reports and Rebuttals, Declarations, depositions, and testimony at hearings and trial. Since September 2002 I have been serving as an expert witness in the case of *Chrimar Systems, Inc. v. Cisco Systems, Inc.*[8], being tried in the U.S. District Court for the Eastern District of Michigan, where my participation has taken the form of Expert Reports and Rebuttals, Declarations, and depositions. Since September 2003 I have been serving as an expert witness in the case of *Lectrolarm v. Vicon et al.*[9], being tried in the U.S. District Court for the Western District of Tennessee, where my participation has taken the form of Expert Reports, depositions, and testimony at hearings. Since October 2005 I have been serving as an expert witness in the case of *Black & Decker, Inc. v. Robert Bosch Tool Corporation*[10], being tried in the U.S. District Court for the Northern District of Illinois, Eastern Division, where my participation has taken the form of an Expert Report. These cases involve telephone and cellular handset security, electronic power conversion technologies, computer network security and powering, remote surveillance camera technology, and worksite radios, respectively.

15. Additional consulting during the last decade includes Bell, Boyd & Lloyd (on behalf of Bosch Security Systems), Bristows (on behalf of Ericsson), Cesari & Mckenna (on behalf of Gerald Pellegrini), Fish and Richardson (on behalf of Eaton Power Quality) and the Mitre Corporation (an FFRDC, on behalf of various agencies of the U.S. government). My employer has been, and continues to be, Harvard University.

16. I am being compensated by Fairchild at the rate of $450 per hour for technical consultation, preparation of reports, and possible deposition and trial testimony.

IV. "Person of Ordinary Skill"

17. At the time of the '851, '366, and '876 patents a person of ordinary skill in the relevant art (power converters and electromagnetic interference[11]) would be characterized as a person with a BSEE (or equivalent work experience), and several years' experience with linear, logic, and power converter circuits, including relevant knowledge of EMI standards and mitigation techniques.

18. Such a person would be familiar with the relevant technology "toolkit," which would include oscillators, comparators, current sources, gates and flip-flops, counters, voltage references, opto-couplers, and the elements of a switchmode power supply: rectifiers, filters, power switches, and regulating feedback.

[8] on behalf of Cisco.

[9] on behalf of defendants Bosch Security Systems, GE Interlogix, Matsushita Electric, Sensormatic Electronics, Sony Electronics, and Vicon Industries.

[10] on behalf of defendant Robert Bosch Tool Corporation.

[11] Hereafter "EMI."

V. Summary of the '851, '366, and '876 Patents

19. The '851, '366, and '876 patents can be grouped into two categories: ***(I)*** the '851 (filed 5/18/98) and '366 (filed 5/16/2000) are closely related patents, differing primarily in the claim language; they deal with the technology of soft-start and of interference suppression (via frequency dithering[12]) in switchmode power converters. ***(II)*** the '876 patent (filed 11/16/98) deals more narrowly with methods for accomplishing such frequency dithering. The following sections provide a technical summary of these patents (asserted claims only).

The '851 and '366 Patents

20. The Abstract and Specification of the '851 and '366 patents describe a switching power converter with two claimed features, namely dithering of the switching frequency, and "soft-start." The frequency dithering (referred to in the patents as "frequency variation" or "frequency jitter") is intended to reduce conducted and radiated EMI to satisfy international standards; the soft-start feature is intended to reduce inrush currents, which otherwise cause component stress and output voltage overshoot.

21. The '851 and '366 patents point out alleged shortcomings in the prior art. With regard to EMI suppression, the use of an input EMI filter adds cost, and is asserted to be ineffective against radiated EMI. And implementing frequency dither by coupling DC input ripple to the switching oscillator suffers from inherent variation of the dither signal with load current.

22. With regard to soft-start, a prior method that shunts a capacitor across the output zener reference (the combination placed in series with the emitting diode of an opto-coupler), in order to force negative feedback during output voltage ramp-up, is asserted to suffer from an initial transient inrush that persists until the DC output voltage reaches the LED threshold voltage.

23. The '851 and '366 patents sought to overcome these alleged shortcomings: They implement frequency dither with an internal oscillator of predictable characteristics; and they use that same internal oscillator to implement a soft-start ramp-up of allowable switch duty-cycle. The oscillator that is illustrated in the patents uses analog methods, specifically the charging and discharging of a capacitor with switched current sources to generate a triangle wave. (Some drawbacks of this method — the need for a large-area integrated capacitor, and/or a current source transistor of low leakage — were addressed in the subsequent '876 patent[13] by subdividing the high-frequency oscillator to generate the low-frequency dithering waveform.)

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[12]The patents use the term *jitter* in this context, a term normally reserved for a different phenomenon. I prefer the generally accepted term *dither*, or, in some contexts, frequency *modulation* or *spreading*.

[13]Though not disclosed in these two patents.

The '876 Patent

24. The Abstract and Specification of the '876 patent describe methods for implementing frequency dither in switching power converters, for reduction of conducted and radiated EMI. The '876 patent points out alleged shortcomings in the prior art. In particular, it is asserted that the use of snubbers and input EMI filters adds size, weight, and cost, and that in practice the design process is likely to be somewhat ad hoc, on a trial-and-error basis, in order to meet regulatory specifications.

25. The '876 patent sought to overcome these alleged shortcomings. In one class of implementations, the (low-frequency) dither signal, which we can call the "modulating" signal, is created by clocking a digital counter with the fundamental switching frequency, then using the subdivided cyclical output as input to a digital-to-analog converter (DAC); the latter's output is then the desired modulating signal.

26. In a second class of implementations, the modulating signal is generated by an analog oscillator of the same design as illustrated in the '851 and '366 patents.

VI. Summary of Relevant Prior Art

27. In the following paragraphs I summarize briefly the technologies related to soft-start and to frequency dithering[14] that are present in publications that appear to qualify as prior art to the '851, '366, and '876 patents. These publications include patents; manufacturers' datasheets, application notes, and other literature; conference and journal articles; and text and reference books on electronics. In some cases there are multiple references containing similar material; for these I have chosen one example for the running text, simply listing or footnoting similar additional references. None of these publications are listed in the patents as cited references.

Soft-start Prior Art References

28. UNITRODE APPLICATION NOTE U-133. This application note appears in the Unitrode 1993-94 databook, and describes the UCC3800–5 series of switch-mode converter ICs. The application note describes their "internal soft-start," which requires no external components. It implements soft-start by charging an internal capacitor with a current source; the resulting ramp causes gradual increase of peak switch current (in current-mode control), or gradual widening of the switch conduction pulse width (in voltage mode); this is illustrated in Fig. 23 of the publication.

29. UNITRODE UCC3800/1/2/3/4/5 DATASHEET; UNITRODE UCC3807-1/-2/-3 DATASHEET; UNITRODE UCC3810 DATASHEET. These datasheets, dated 5/93, 1/95, and 12/94, respectively, describe and specify the corresponding switch-mode converter ICs. Each incorporates "internal full cycle soft start," consisting of an

[14] In some cases a reference listed under one category (i.e., either "Soft-start" or "Frequency Dithering") may contain elements relevant to the other category, though not explicitly listed under the other category.

integrated capacitor charged by an internal current source, the resulting ramp used to implement gradual startup.

30. UNITRODE APPLICATION NOTE U-128. This application note appears in the Unitrode 1993–94 databook, and describes the UC3823A,B and UC3825A,B series of switchmode converter ICs. These implement soft-start by charging an external capacitor with an internal current source; the resulting ramp is used to implement gradual startup, in either current mode or voltage mode.

31. UNITRODE DATASHEETS: UC3823; UC3825; UC3823A,B/3825A,B; AND UC3828. These datasheets, dated between 2/93 and 11/94, describe and specify the corresponding switchmode converter ICs. These implement soft-start by charging an external capacitor with an internal current source; the resulting ramp is used to implement gradual startup, in either current mode or voltage mode.[15]

32. NATIONAL SEMICONDUCTOR APPLICATION NOTE 918. This application note, dated January 1994, describes the operation of the LM3001/LM3101 switchmode converter IC pair. The primary-side IC (LM3001) uses an external capacitor, charged by an internal current source, to create a ramp waveform as input to the PWM comparator; this causes a gradual ramp-up of pulse duty-cycle at startup.

33. NATIONAL SEMICONDUCTOR LM3001 DATASHEET. This datasheet, found in the National Semiconductor 1995 Power ICs Databook, describes in greater detail the operation of the LM3001 switchmode converter IC. Its Figure 4 and associated discussion show the progressive growth of pulse duty cycle during soft-start, as the capacitor voltage ramps up during constant-current charging.

34. NATIONAL SEMICONDUCTOR DATASHEETS: LM2577; LM2587; LM2588; LM2597; LM2671; AND LM2672. These datasheets, dated between 1/95 and 8/97, describe and specify the corresponding switchmode converter ICs. They all implement soft start, with an external capacitor setting the timescale. Several of these datasheets include soft-start capacitor charging currents; the LM2597 (I_{SS}=1.6μA) gives the most detailed discussion, with a graph (its Figure 13) showing progressive growth of switch duty cycle during soft start.

35. LINEAR TECHNOLOGY DATASHEETS: LTC1435; LTC1504; AND LTC1553. These datasheets, found in the Linear Technology 1996 and 1997 Linear Databooks (volumes V and VI), describe and specify the corresponding switchmode converter ICs. They implement soft start by using an internal current source to charge an external capacitor, the resulting voltage ramp causing a progressive growth of switch conduction angle.

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[15]Additional Unitrode switchmode converter ICs that include soft-start with an external capacitor include the UC3827-1/-2, UC3840, UC3841, UC3851, UC3854, UC3860, UC3874-1/-2, and UC3875/6/7/8. Their datasheets are dated between 5/93 and 3/98.

36. MAXIM DATASHEETS: MAX767; MAX786; AND MAX796/7/9. These datasheets, found in the Maxim 1995 and 1996 New Releases Databooks (volumes IV and V), and dated 5/94, 5/94, and 11/94, respectively, describe and specify the corresponding switchmode converter ICs. They implement soft start by using an internal current source to charge an external capacitor, the resulting voltage ramp causing a progressive increase in current-limit setpoint, therefore a progressive growth of switch conduction angle.

37. MOTOROLA DATASHEETS: MC34023; MC34025; MC34066; AND MC34067. These datasheets, found in the Motorola Analog ICs Device Databook, DL128/D Rev. 5, dated 1995, describe and specify the corresponding switchmode converter ICs. They implement soft start by using an internal current source to charge an external capacitor. In the MC34023 and MC34025 the resulting voltage ramp causes a progressive growth of switch duty cycle. In the MC34066 and MC34067 the voltage ramp is used to vary the frequency of the internal oscillator.

38. POWER INTEGRATIONS DATASHEETS PWR-SMP240 AND PWR-SMP260; AND ARTICLE "OFF-LINE POWER INTEGRATED CIRCUIT FOR INTERNATIONAL RATED 60-WATT POWER SUPPLIES" BY R. A. KELLER.[16] The datasheets (dated 2/92) and conference article (2/23-27/92) describe a pair of switchmode converter ICs from Power Integrations that implement fully internal soft-start (i.e., without the need for any external components). According to the datasheets and article, this is done by clocking an internal counter from the switching oscillator, coupling the counter output codes to a DAC, then using the DAC's output to set a progressively increasing current limit. This is termed "Full cycle soft-start – Linear ramp up of switching current" on the datasheets. It results in progressively increasing switch conduction angle during the soft start sequence.

39. ARTICLE "OFF-LINE PWM SWITCHING REGULATOR IC HANDLES 3 W" BY F. GOODENOUGH.[17] This article describes the Power Integrations PWR-SMP3 switchmode converter IC, intended for low-power voltage-mode flyback converters. According to the article, the IC includes soft-start, with on-chip current source and capacitor to limit the duty cycle and peak current during startup.

40. CHERRY SEMICONDUCTOR DATASHEET CS-51021/51023. This datasheet, dated 2/20/97, describes and specifies the corresponding switchmode converter ICs. They implement soft-start by charging an external capacitor with an internal current source; the resulting ramp is used to implement gradual startup of the voltage-mode PWM converter.

41. SGS-THOMSON TEA2260/1 DATASHEET AND APPLICATION NOTE AN376. The datasheet, marked "©1994 SGS-THOMSON Microelectronics," de-

[16] IEEE Seventh Annual Applied Power Electronics Conference and Exposition, Feb 23-27, 1992, Boston, MA; FCS0527805–814.

[17] *Electronic Design*, March 22, 1990, pp. 35–39; FCS0528084–089.

scribes and specifies the TEA2260 series switchmode power supply controllers, which include a soft-start circuit, whereby the switch maximum duty cycle increases gradually during startup, according to a ramp voltage on a capacitor charged by a current source. The application note, with the same copyright marking, provides additional details of the IC's operation and application.

Frequency-Dithering Prior Art References

42. U.S. PATENT NO. 5,631,920: "SPREAD SPECTRUM CLOCK GENERATOR." This patent ("the '920 patent," or "the Hardin patent"), issued 5/20/97, describes a circuit that modulates the frequency of a voltage-controlled oscillator according to a specific modulating profile, to broaden and flatten the amplitudes of generated EMI spectral components. It uses a counter, ROM, and DAC to generate the analog modulating waveform that is applied to the VCO.

43. U.S. PATENT NO. 4,507,796: "ELECTRONIC APPARATUS HAVING LOW RADIO FREQUENCY INTERFERENCE FROM SYSTEM CLOCK SIGNAL." This patent ("the '796 patent," or "the Stumfall patent"), issued 3/26/85, describes a circuit that modulates the frequency of a voltage-controlled oscillator with either a sinusoidal or random waveform, for reduced EMI.

44. U.S. PATENT NO. 4,638,417: "POWER DENSITY SPECTRUM CONTROLLER." This patent ("the '417 patent," or "the Martin patent"), issued 1/20/87, describes a circuit, for use in power converter applications, that modulates the frequency of a voltage-controlled oscillator to reduce or eliminate spectral components. It uses a counter, ROM, and DAC to generate the analog modulating waveform that is applied to the VCO that is the switching oscillator for the converter.

45. U.S. PATENT NO. 5,498,995: "SHORT CIRCUIT FREQUENCY SHIFT CIRCUIT FOR SWITCHING REGULATORS." This patent ("the '995 patent," or "the Szepesi patent"), issued 3/12/96, describes operational aspects of the National Semiconductor LM3001/3101 switchmode converter IC pair, in particular its technique for reducing the switching frequency, in a continuous manner, in response to output overload. This frequency-shifting operation is mentioned also in the LM3001 datasheet, referenced above in the "Soft-start Prior Art References" section of this report, as well as in the LM3101 datasheet (see next paragraph).

46. NATIONAL SEMICONDUCTOR LM3101 DATASHEET. This datasheet, found in the National Semiconductor 1995 Power ICs Databook, describes in greater detail the operation of the LM3001/3101 switchmode converter IC chipset. Of relevance to frequency dithering, it describes the operation of the short-circuit frequency shift circuit, wherein the oscillator frequency is varied, in a continuous manner, in response to output overload.

47. U.S. PATENT NO. 5,555,168: "FREQUENCY MODULATED, SWITCHING POWER SUPPLY." This patent ("the '168 patent," or "the Ferrario patent"), issued

9/10/96, describes a switching power converter circuit that modulates the frequency of its internal oscillator in a continuous manner, according to the instantaneous AC input voltage, in order both to reduce EMI and to increase efficiency.

48. ARTICLE "PROGRAMMED PULSEWIDTH MODULATED WAVEFORMS FOR ELECTROMAGNETIC INTERFERENCE MITIGATION IN DC-DC CONVERTERS" BY A. C. WANG AND S. R. SANDERS.[18] This article describes the use of frequency dithering via a digitally controlled analog waveform for EMI reduction in DC-DC power converters.

49. ARTICLE "ACOUSTIC NOISE REDUCTION IN SINUSOIDAL PWM DRIVES USING A RANDOMLY MODULATED CARRIER" BY T. G. HABETLER AND D. M. DIVAN.[19] This article describes the use of frequency dithering of the oscillator in switching power converters motor drives, in order to spread the energy in the acoustic spectrum that is normally concentrated at a few frequencies. Two methods for generating the modulating waveform are illustrated, namely (1) the use of sampled band-limited analog noise, and (2) the use of digitally-generated waveforms. In the latter technique the oscillator clocks a counter, the output of which indexes a lookup table in ROM whose output drives a DAC.

50. ARTICLE "FREQUENCY MODULATION OF SYSTEM CLOCKS FOR EMI REDUCTION" BY C. D. HOEKSTRA.[20] This article describes the use of frequency dithering by digital methods (modulus modulation) in phase-locked-loop clocking circuits, to reduce EMI. Both square wave and triangle wave modulation waveforms are described.

51. PRODUCT ANNOUNCEMENT "CRYSTAL OSCILLATOR REDUCES EMI FROM COMPUTERS" BY C. B. CHESHER.[21] This product announcement describes NEL's Spread Spectrum HS-7800 line of oscillators, which are claimed to exhibit reduced radiated emissions. The announcement describes the technology as using the modulating waveform of the Hardin patent, that waveform modulating a voltage-controlled oscillator.

52. TEXTBOOK "LABORATORY MANUAL FOR THE ART OF ELECTRONICS" BY P. HOROWITZ AND I. ROBINSON.[22] This laboratory exercise teaches the use of a clocked counter coupled to a DAC as a method of generating a voltage waveform. A similar technique is taught in *Analog-Digital Conversion Handbook,* D. H. Sheingold, ed., Prentice Hall, 1986, pp. 124–26; and in *Advanced Electronic Circuits,* U. Tietze and Ch. Schenk, Springer-Verlag, 1978, pp. 424–26.

53. POWER INTEGRATIONS SMP211 DATASHEET. This datasheet is dated

[18] *IEEE Trans. Pwr. Elec.*, **8**, 4 (Oct. 1993), pp. 596–605.
[19] *IEEE Trans. Pwr. Elec.*, **6**, 3 (Jul. 1991), pp. 356–363.
[20] *Hewlett-Packard Journal*, Aug. 1997.
[21] NEL Frequency Controls, Inc., Burlington, Wisconsin, 7/4/97.
[22] Cambridge University Press, 1981, pp. 17-1 ff.

1/96, and describes and specifies the switchmode converter IC shown as prior art in Figure 1 of the '366 and '851 patents. Of relevance here (for reasons given later, in ¶¶69 and 97) is a block diagram showing the ICs functional arrangement, including an oscillator with sawtooth, clock, and D_{MAX} outputs, and a voltage reference block whose input $R_{\mathrm{EXT+}}$ is used to set internal bias currents. This reference is relevant also to soft-start.

54. SGS-THOMSON TEA2262 DATASHEET. This datasheet, dated 4/96, describes and specifies a switchmode converter IC that includes circuitry to reduce the switching frequency by a factor of 4 during startup. It includes also a soft-start circuit, which permits a gradual increase in switch duty cycle. Additional information can be found in the SGS-Thomson App Note AN376 (¶41), which describes the TEA2260 and TEA2261 variants.

55. TOKO TK75001 DATASHEET. This datasheet appears in the 1996 Toko Power Conversion IC Data Book, and describes and specifies a switchmode converter IC that includes a "frequency-reduction" function that is activated during overload conditions, and that reduces the operating frequency by approximately a factor of 2.

56. PHILIPS TEA1504 DATASHEET. This datasheet, dated 3/17/98, describes and specifies a switchmode power converter IC that includes a frequency control circuit to reduce the oscillation frequency of the voltage-mode PWM to 40% of normal, under light-load conditions.

57. ARTICLE "A 5A 100 KHZ MONOLITHIC BIPOLAR DC/DC CONVERTER" BY F. J. DESTASI AND T. SZEPESI.[23] This article describes a monolithic switching converter that includes a frequency adjustment feature whereby the oscillator frequency can be varied in the range of 100 kHz to 200 kHz.

VII. Validity of the Asserted Claims

58. In this section I compare the asserted claims of the '851, '366, and '876 patents with the prior art references summarized above. In each case I have been asked whether a single prior-art reference meets all the claim limitations ("anticipation"). I have also been asked whether one of ordinary skill in the art at the time of the patent would have found the differences between the claimed invention and the prior art to be obvious ("obviousness"). For the latter question I understand that it is permissible to combine the teachings of prior art references, particularly if motivation is found within them for such combination.

59. In reading the asserted claims I understand that there is disagreement between the parties as to the meaning of some claim terms, and that the meaning of any claim terms on which agreement cannot be reached by the parties will ultimately

[23]Fifth European Conference on Power Electronics and Applications, Brighton, England; paper reprinted in the proceedings, published by the European Power Electronics Association, Brussels, pp. 201–208.

be resolved through a Markman ruling by the Court. Because this report is due before such final resolution, I will use the alternative constructions that have been provided to me in comparing the asserted claims with the prior art. In the following sections I will frequently paraphrase the patents' language, to simplify the discussion.

'366 Patent, Claim 1

60. This independent claim deals with the soft-start aspect of the '366 patent. Its elements include a controllable switch, an oscillator that provides a maximum duty-cycle signal ("D_{max}"), a drive circuit, and a soft-start circuit that inhibits drive during at least a portion of otherwise allowable drive (i.e., the on-state of D_{max}).

61. I am informed that Power Integrations proposes a means-plus-function construction of the "soft start circuit" element of Claim 1. I understand this to mean that the claim element would be limited to the structures disclosed in the patent specification (and equivalents) that perform the recited function. According to the claim construction charts that have been given to me, the parties disagree as to whether the embodiment of Fig. 1 would be included, were this claim element to be construed as means-plus-function.[24] Soft-start was being practiced, in the relevant time frame and in the context of switchmode power converters, and there were numerous known circuit methods of implementing soft-start, detailed below in ¶¶62–67 and in the attached claim chart exhibits.

62. The Unitrode UCC3800 series, described in their respective datasheets, and in further detail in Application Note U-133, implements all elements of Claim 1 of the '366 patent when used as a switchmode controller with an external MOSFET switch, its suggested mode of application. This series of controllers implements fully internal soft-start (no external components), using a ramp voltage (generated by charging a capacitor with a current source) to establish a gradual lengthening of switch conduction time during initial startup. This is the way soft-start is illustrated in the embodiments of Figures 3, 6, and 9 of the '366 patent. The attached claim chart provides an element-by-element analysis of this prior-art reference, which anticipates Claim 1 regardless of whether or not the soft-start circuit element is construed as means-plus-function.

63. To expand on this statement in somewhat greater detail, Figure 23 of the U-133 publication illustrates the gradual lengthening of switch conduction angle during soft-start, just as illustrated in the patent's Figure 4; see Figure 1, below. The ramp waveform is generated by a current source charging an internal (on-chip) capacitor, as described at 9-352 (U-133); and as shown in Figures 1, 20, and 22 (U-133), and the block diagrams in the UCC3800-series, UCC3807-series, and UCC3810 datasheets.

[24]From a purely engineering point of view, the PWM converter whose structure is shown in Fig. 1 performs a soft-start function as described in the asserted claims of the '366 patent.

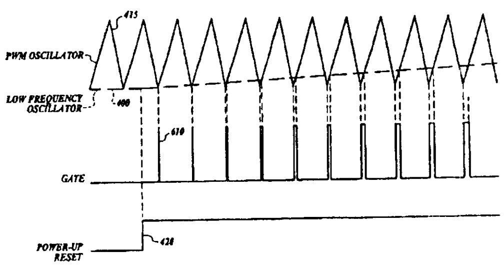

Fig. 4

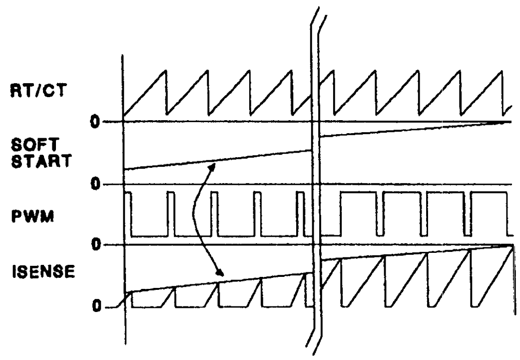

Figure 23

Figure 1: Balakrishnan '366 Patent (left); Unitrode U-133 App Note (right)

64. These datasheets explicitly show circuitry that provides a signal to set the maximum duty cycle; they additionally specify "Maximum Duty Cycle" (which I will abbreviate $D_{\max}$) values (50% for the UCC3801, -04, and -05; 78% for the UCC3807 series, with representative component values; and 50% for the UCC3810). For the UCC3801, -04, and -05 the $D_{\max}$ signal is created by a type-T flip-flop, toggled by the PWM oscillator, and output on the Q terminal of the T-flop; for the UCC3807 series the $D_{\max}$ signal is the signal output by the oscillator "OSC" in the block diagram, whose circuit is reminiscent of the classic 555 oscillator, and whose intrinsic duty cycle is set by resistor ratios; and for the UCC3810 the $D_{\max}$ signal is created by a toggling divide-by-2 driven by the oscillator. In all cases the $D_{\max}$ signal enables an AND gate, through which the PWM signal drives the MOS power switch; this is the same structure as the patent's Figures 3, 6, and 9.

65. The Goodenough article (¶39) claims to describe the Power Integrations PWR-SMP3 switchmode converter IC. Its Figure 2 includes the switch, oscillator, and drive circuits; and the text includes a paragraph describing the internal soft-start circuit, in which a current source charges a capacitor, limiting the duty cycle and peak switch current during startup. The text describes a maximum duty cycle of 50%, which is implemented in the block diagram of Figure 2 by the topmost signal from the oscillator block, once again ANDed with the PWM signal before driving the MOS power switch. The $D_{\max}$ circuitry is shown also on the block diagram (Figure 3) on the PWR-SMP3 datasheet,[25] and is confirmed in full detail in the schematics provided by Power Integrations.[26] Those schematics are confirmatory in further showing soft-start circuitry, in which a current source charges a capacitor, from which the resulting ramp waveform causes a progressive growth of maximum switch conduction angle. The attached claim chart provides an element-by-element analysis of the Goodenough prior-art reference, which anticipates Claim 1 regardless of whether or not the soft-start circuit element is construed as means-plus-function.

[25] Datasheet marked "B 7/91"; Figure 3 is the functional block diagram.
[26] Marked "PS03" in the title blocks, 21 pages, and dated 3/28/90.

66. Additional prior-art references that include all the limitations of Claim 1, but which require an external capacitor for ramp generation, include the Unitrode UC3820 series (with Application Note U-128), UC3840/1, UC3850/1/4, UC3860, and UC3874/5/6/7/8; National Semiconductor LM3001/3101 (with Application Note 918); National Semiconductor LM2577/8, LM2588 (with the deStasi and Szepesi reference); LM2597, and LM2671/2; Linear Technology LTC1435, LTC1504, and LTC1553; Maxim MAX767, MAX786, and MAX796/7/9; Motorola MC34023/5; Cherry Semiconductor CS-51021/3; and SGS-Thomson TEA2260/1 (with Application Note AN376). That is, these references anticipate Claim 1, regardless of whether or not the soft-start circuit element is construed as means-plus-function. In addition, the SMP240/60 datasheet and the associated Keller article describe power converters that use a digitally-generated ramp for soft start, but which otherwise meet the limitations of Claim 1.[27] That is, they anticipate Claim 1 if the soft-start element is not construed as means-plus-function.

67. Among these references, the TEA2260/1 is noteworthy, in that its implementation of the soft start function is essentially the same as that of the '366 patent. In particular, it uses a pair of voltage comparators, one for the PWM function and one for the soft-start; this is shown in the block diagram of the datasheet, and in greater detail in Figures 14–16 (and discussion) in the associated Application Note AN376. Like the references above, it includes all the limitations of Claim 1.

68. To the extent that any of these prior-art references may incompletely meet the limitations of Claim 1, the difference between the prior-art reference and the claimed invention would have been obvious to one of ordinary skill in the art. Additionally, if the soft-start circuit element is deemed means-plus-function, and if that "circuit" is ruled to be exactly the box labeled **410** in the patent's Figures 3, 6, and 9 (and corresponding discussion at 7:9–18), the differences between that circuit and the prior-art circuits would have been obvious to one of ordinary skill: the prior-art circuits already have a $D_{\max}$ signal, thus ANDing it with another $D_{\max}$ signal that grows with time would have suggested itself.

69. If the soft-start circuit element is not means-plus-function, or if it is deemed means-plus-function and Figure 1 of the '366 patent is included within the means-plus-function embodiments, then Figure 1 includes all elements of Claim 1. In particular, the block labeled SMP211 includes a switch, an oscillator with a $D_{\max}$ signal, a drive circuit, and the soft-start circuit described in the specification at 2:65–3:17.

70. The allowance of Claim 1 would appear to be at odds with this conclusion; however, the existence of a $D_{\max}$ signal is not shown in Figure 1, nor was it disclosed

[27]It appears that the actual silicon implementation of the SMP240/260 may have included circuitry for soft-start using *analog* ramp generation. (PWR-SMP260 Design Specification Rev 2, 7/12/91, at PIF129993–5.)

to the examiner, according to the prosecution history.[28] The SMP211 datasheet (apparently revision C, dated 1/96), however, has a "functional block diagram" that includes a block labeled "oscillator," with outputs labeled $D_{\max}$, CLOCK, and SAW; and the waveforms shown next to these outputs are similar to those in the patent's Figures 3, 6, and 9.

'366 Patent, Claim 2

71. Dependent Claim 2 adds to Claim 1 the limitation that the elements of Claim 1 comprise a monolithic device.

72. The Unitrode references (¶¶28–29) and the Goodenough reference (¶39), each of which meets all the limitations of Claim 1, describe monolithic devices; each therefore meets the limitations of Claim 2, and anticipates the asserted claim. In addition, the SMP240/260 datasheet and associated Keller article anticipate Claim 2, if the soft-start circuit element is not construed as means-plus-function.

73. Furthermore, the term *monolithic* is widely understood by electronics engineers to include integrated circuits that may require some external components. For example, Power Integrations' own datasheets for the PWR-SMP3, the SMP211, and the SMP240/260 each describe the respective ICs as "monolithic." And each of these requires additional capacitors and resistors in order to function, even at the most basic level. The same use of *monolithic* is found generally, where it is used to distinguish a monolithic IC from a hybrid or a discrete implementation. The term *fully integrated* is used for a monolithic circuit that requires *no* external components. Thus under common engineering usage the prior art references cited above in ¶66 (which require an external capacitor to set the soft-start time constant) are "monolithic," and therefore also anticipate the asserted claim.

74. If the soft-start circuit element of Claim 1 is deemed means-plus-function, and if that circuit is limited to the box labeled **410** in the patent's figures, then Claim 2 does not require that the soft-start waveform generator be monolithic. Under these conditions, therefore, regardless of the meaning of "monolithic," the capacitor (and any other components that are not included in the monolithic inventory of terminals, switch, oscillator, drive circuit, and soft-start circuit) can be off-chip. This would also sweep in the prior-art references of ¶66 as anticipatory.

75. If Claim 1 is invalid, for any of the reasons given above, it is my opinion that the added limitation of Claim 2 would have been obvious to one of ordinary skill in the art. That is because the implementation of a useful circuit in monolithic form has become what might be described as the standard paradigm of contemporary electronics, for reasons at least of size, cost, system complexity, and reliability.[29] The

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[28] Prosecution history of the '851 patent, Amendment and Response, 3/10/00, p. 6; this applies to the '366 divisional.

[29] The examiner cited this reason in rejecting original dependent Claim 34, which added the "monolithic" limitation to rejected original Claim 29, saying "However,

reduction of a useful circuit to a monolithic chip is not an "invention": it is the logical next step. Claim 2 is invalid on the basis of obviousness, if Claim 1 is invalid.

'366 Patent, Claim 8

76. Dependent claim 8 adds to Claim 1 a line-powered unregulated DC supply, and a transformer whose primary is powered by the DC and switched by the switch element of Claim 1, and whose secondary can be coupled to a load.

77. This is a standard configuration for an off-line[30] switchmode power converter. In fact, the added elements describe precisely the power converter configuration of the patent's Figure 1[31]. Thus, if Figure 1 meets the limitations of Claim 1, (as it does if the soft-start element either is not means-plus-function, or if it is and Figure 1 is included within its embodiments; see ¶69–70), then it meets also the limitations of Claim 8.[32]

78. Turning to the prior-art teachings cited above (in the context of Claims 1 and 2), the Unitrode Application Note U-133 describes the use of the UCC3800-series switchmode converter ICs with rectified AC line power, and transformer-coupled output configurations (both "forward" and "flyback").[33] This single reference thus anticipates Claim 8.

79. Likewise, the elements of Claim 8 are found in National Semiconductor Application Note 918 (its Figure 8 and discussion), and in the Goodenough article (¶¶39 and 65). Both references illustrate isolated line-powered converters with an output transformer; both anticipate Claim 8.

80. The use of a switchmode converter in an isolated line-powered configuration ("off-line"), which requires both rectified DC input and transformer isolated output, is a standard power converter configuration. It is known and understood by every person of ordinary skill in the art. The use of an input bridge rectifier and filter capacitor is so well known that it is often not even stated explicitly: see, for example, Figure 9 of the LM3001 datasheet (¶33), where the input is labeled simply

it would have been obvious to one of ordinary skill in the art at the time of the invention to incorporate Prior Art Fig. 1 as an integrated circuit for the benifit [sic] of implementing a compact single package. Claim 34 is obvious."

[30]It is worth noting that the term "off-line" in this context does not have its usual contemporary meaning (disconnected from a network); rather it means "run *off* the power *line*." Though this unfortunate terminology has become standard, I prefer to use the term "line-powered."

[31]Where, it should be noted, the output terminals are incorrectly labeled "AC Out," and the input EMI filter is incorrectly labeled "125."

[32]Moreover, even were Fig. 1 not to meet the limitations of Claim 1, it contains all the additional limitations of Claim 8.

[33]And explicit circuitry is shown in Unitrode Application Notes U-96A and U-100A, two of the four listed references at the end of U-133.

"V_{IN} +127–185 V_{DC}," universally understood in the context of off-line switchers as the output of a rectifier bridge. And the use of transformer coupling in isolated off-line converters is simply universal, whether in the "forward," "flyback," "push-pull," "half-bridge," or other configurations. These configurations are taught in switching power converter references, and even in general references, for example in Chapter 6 of H&H (at 360ff) and in Tietze and Schenk (1978 ed., at 201–2).

81. It is thus my opinion that the use of the alleged invention of Claim 1 in the isolated line-powered configuration of Claim 8 would have been abundantly obvious to one of ordinary skill in the art.

'366 Patent, Claim 9

82. Independent Claim 9 deals with subject matter similar to that of Claim 1, but differs in the preamble ("A regulation circuit comprising," rather than "A pulse width modulated switch comprising") and in the omission of the oscillator element of Claim 1. I have been informed that, as with Claim 1, Power Integrations has proposed that the "soft start circuit" claim element be construed as a means-plus-function element.

83. The omission of the oscillator element, however, creates a problem when one tries to understand the meaning of the "drive circuit" element of this claim. That element reads *"a drive circuit that provides said drive signal for a maximum time period of a cycle;"*. However, the claim recites no oscillator, or other cyclical process. The claim thus lacks definiteness, in my view (a technical observation, not a legal opinion).

84. Even assuming definiteness, all of the prior art cited above, in the context of validity of Claims 1, 2, and 8, are examples of *regulated* switchmode converters, and are thus applicable to this claim. It is my conclusion, therefore, that the prior art cited in ¶¶62–70 renders Claim 9 invalid by anticipation and/or obviousness.

'366 Patent, Claim 10

85. Dependent Claim 10 adds to Claim 9 an oscillator with a maximum duty cycle signal, the latter comprising the "maximum time period" (of a cycle) recited in the "drive circuit" claim.

86. Claim 10 resolves the problem raised in ¶83, because an oscillator is inherently cyclic. Thus Claim 10 is essentially the same as Claim 1, with the replacement of "a pulse width modulated switch" with "a regulation circuit." Because all of the prior art cited in the context of validity of Claims 1, 2, and 8 are examples of *regulated* switchmode converters, they are applicable to this claim. It is my conclusion, therefore, that the prior art cited in ¶¶62–70 renders Claim 10 invalid by anticipation and/or obviousness.

'366 Patent, Claim 14

87. Dependent Claim 14 adds a "frequency variation circuit" to Claim 9, providing a "frequency variation signal" that dithers the maximum time period recited in Claim 9.

88. As discussed in ¶83, Claim 9 may be deemed invalid owing to lack of definiteness, a problem that this dependent claim does not resolve. That is, Claim 14 does not clarify what the "cycle" of Claim 9 is, and therefore also lacks definiteness.

89. If, however, Claim 14 is found not to be invalid by reason of indefiniteness, the dither limitation added by Claim 14 must be examined for invalidity in view of the prior art. Because the closely-related '851 patent deals primarily with dither (beginning with its independent Claim 1), I will defer the discussion of the '366 patent's Claim 14, and group it with the subsequent discussion of the asserted claims of the '851 patent, below.

'366 Patent, Claim 16

90. Dependent Claim 16 adds to Claim 9 the limitation that the elements of Claim 9 reciting "said a first terminal, said second terminal, said oscillator and said soft start circuit" comprise a monolithic device. As I understand it, a reference to "said" *something* must have that *something* as an explicit antecedent. However, Claim 9 lacks the word "oscillator," a problem discussed above in ¶83. Besides creating a problem of interpretation for one of skill in the art, the lack of an antecedent would appear to invalidate Claim 16.

91. If, however, Claim 16 is found not to be invalid by reason of lack of antecedent basis, or of indefiniteness, then the discussion of invalidity of Claim 2 on the basis of obviousness, above (¶75), applies with equal force to Claim 16. Claim 16 is invalid on the basis of obviousness.

'366 Patent, Claim 18

92. Dependent Claim 18 is analogous to Claim 8, in adding to Claim 9 a line-powered unregulated DC supply, and a transformer whose primary is powered by the DC and connected to the "first terminal" element of Claim 9, and whose secondary can be coupled to a load.

93. As discussed in ¶83, Claim 9 (upon which this claim depends) is flawed, in not providing any oscillator or other cyclical process to give definite meaning to the term "maximum time period of a cycle." If Claim 9 is thus rendered invalid, Claim 18 is likewise. However, if this claim is found not to be invalid, then from the facts and reasons elucidated above in ¶¶77–81 it is my opinion that Claim 18 is invalid by anticipation, by obviousness, or both.

'851 Patent, Claim 1

94. The '851 patent is closely similar to the '366 patent, differing primarily in claim language. One might think of the '366 patent as the "soft-start" patent (the asserted independent claims deal with soft-start, and dither is added as a dependent claim), whereas the '851 might be thought of as the "dither" patent (the asserted independent claims deal with dither, and soft-start is added as a dependent claim).

95. This independent claim deals with the frequency dithering aspect of the '851 patent. Its elements include a controllable switch; a frequency variation circuit; an oscillator whose frequency can be varied according to the output signal of the frequency variation circuit, and which further provides a maximum duty-cycle signal ("D_{max}"); and a drive circuit that drives the switch into conduction when D_{max} is in one state and the oscillation signal is below a variable threshold.

96. According to the claim construction charts that have been given to me, the parties disagree as to whether the "frequency variation circuit" element of Claim 1 is to be interpreted as a means-plus-function element.[34] If the Court so rules, I understand this to mean that the claim element is limited to the structures disclosed in the patent specification (and equivalents) that perform the recited function.

97. If, on the other hand, the frequency variation circuit element is not construed as a means-plus-function element, Figure 1 includes all the elements of Claim 1. In particular, the block labeled SMP211 includes a switch, an oscillator with a D_{max} signal, a drive circuit, and portions of the (imperfect) frequency-variation circuit described in the specification at 2:27–39 and 3:9–37. The rest of the frequency-variation circuit includes resistor **140**, unregulated DC supply **10, 20**, and the resistor connected between terminals **125** and **130** of the SMP211. The ripple current supplied to the $R_{\mathrm{EXT+}}$ modulates the internal bias currents in the 211, as detailed in the SMP211 schematics[35] produced by Power Integrations; the modulated current in turn modulates the oscillator frequency, consistent with the patent's description at 3:19–26. That is, Figure 1 invalidates Claim 1, by anticipation.

98. The allowance of Claim 1 would appear to be at odds with this conclusion; however, the existence of a D_{max} signal is not shown in Figure 1, nor was it disclosed to the examiner, according to the prosecution history.[36] The SMP211 datasheet (apparently revision C, dated 1/96), however, has a "functional block diagram" that includes a block labeled "oscillator," with outputs labeled D_{max}, CLOCK, and SAW;

[34] By analogy with the disagreements over the embodiments included in the agreed-upon means-plus-function "soft start circuit," there is likely to be a dispute as to whether the patent's Figure 1 is to be included in the illustrated embodiments, if the Court rules in favor of a means-plus-function interpretation for the "frequency variation circuit" element of Claim 1.

[35] A thirty page set, marked "PS10" in the title blocks.

[36] Amendment and Response, 3/10/00, p. 6.

and the waveforms shown next to these outputs are similar to those in the patent's Figures 3, 6, and 9.

99. Prior art references not cited in the '851 patent that include all the elements of Claim 1, (again assuming no means-plus-function claim elements) include the Szepesi patent and related National Semiconductor LM3001/3101 datasheets; the datasheet for the TK75001; the datasheet for the TEA1504 integrated circuits; the datasheet for the LM2588 and related deStasi & Szepesi article; the TEA2260/1 datasheet and related Application Note AN376; and the TEA2262 datasheet. Additionally, to one of skill in the art the title and context of the Ferrario patent would render any missing claim elements obvious.[37]

100. The TEA2260/1 datasheet and related Application Note AN376 provide a particularly clear anticipatory reference. In the Application Note there is provided a block diagram (Figure 8) for the TEA2260/1 that is included within the application circuit of Figure 44. The block diagram shows the switch and terminals, the oscillator (with both sawtooth and maximum duty cycle signals[38]), and the switch drive circuit. In its application in Figure 44 there is provided a frequency variation circuit (the npn transistor that sinks current from pin 11, along with RC drive circuit to its base terminal), whose operation is described on page 32, §V.1. (The later TEA2262 IC integrated the frequency variation circuitry onto the chip, as shown in the datasheet's block diagram.)

101. If the frequency variation circuit element is construed as a means-plus-function element, and if the patent's Figure 1 (labeled "Prior Art") is included as an illustrated embodiment, then Figure 1 once again includes all elements of Claim 1. In particular, the block labeled SMP211 includes a switch, an oscillator with a $D_{\max}$ signal, a drive circuit, and portions of the (imperfect) frequency-variation circuit described in the specification at 2:27–39 and 3:9–37. The rest of the frequency-variation circuit includes resistor **140**, unregulated DC supply **10, 20**, and the resistor connected between terminals **125** and **130** of the SMP211. That is, Figure 1 invalidates Claim 1, by anticipation. As explained in ¶98, this paradoxical conclusion is justified by the fact that the existence of a $D_{\max}$ signal in the SMP211 block of Figure 1 was not disclosed to the examiner.

102. If the frequency variation circuit element is construed as a means-plus-function element, but the patent's Figure 1 is excluded as an illustrated embodiment, then the structure that performs the recited function (providing a frequency variation signal) consists of corresponding circuitry in the patent's Figures 3, 6, and 9, and associated discussion in the specification. That structure consists of circuitry (including a low frequency oscillator) that generates a periodic analog triangle-like waveform by charging and discharging a capacitor with current sources, and additional circuitry

[37] Similar reasoning applies, likewise, to the Habetler and Divan article; the Martin patent; and the Wang & Sanders article.

[38] Described in §II.4–II.5.

to vary the frequency-setting current into the PWM oscillator.

103. Under this construction, several prior art references render Claim 1 obvious to one of skill in the art, and therefore invalid. For example, the Martin patent, which teaches oscillator modulation in a DC/DC switching converter for the purpose of reducing EMI spectral components, uses a digital waveform generation method for the (quasi-random) dither signal; one of skill in the art, noting the Hardin patent's use of a triangle-like waveform for a similar spread-spectrum objective, would know that a simple analog triangle wave generator could be substituted.

104. Similar considerations apply to combinations that include these patents, the Ferrario patent, and the papers and publications of Wang and Sanders, Habetler, and Hoekstra. These render Claim 1 obvious, regardless of whether or not the frequency variation element is finally construed to be means-plus-function.

'851 Patent, Claim 2

105. Dependent Claim 2 adds to Claim 1 the limitation that the elements of Claim 1 comprise a monolithic device.

106. This claim is anticipated by the TK75001, TEA1504, and TEA2262 references. Each of them includes a switch with first and second terminals, a frequency variation circuit that provides a frequency variation signal, an oscillator with a D_{max} signal whose frequency can be varied by the frequency variation signal, and the requisite switch drive circuit. Each of them is monolithic.

107. If Claim 1 is invalid, for any of the reasons given in the previous section, then Claim 2 is invalid for reasons of obviousness, by the same reasoning as in ¶73, above.

'851 Patent, Claim 4

108. Dependent Claim 4 adds to Claim 1 a soft-start circuit, employing the same signal used to produce the frequency variation. I understand that Power Integrations proposes that the "soft start circuit" element be interpreted as a means-plus-function element, and that the embodiments of Figures 3, 6, and 9 include the corresponding structures. However, the parties disagree (under such a means-plus-function construction) as to whether the patent's Figure 1 would be included in the illustrated embodiments of the corresponding structure.

109. This claim construction uncertainty means that four possibilities must be addressed, with respect to means-plus-function interpretations in Claims 1 and 4: 1) both the soft-start circuit element of Claim 4 and the frequency variation circuit element of Claim 1 are means-plus-function; 2) neither the soft-start circuit element nor the frequency variation circuit element is means-plus-function; 3) the frequency variation circuit element is means-plus-function, but the soft-start circuit element is not; and 4) the soft-start circuit element is means-plus-function, but the frequency

variation circuit element is not.

110. For cases (1) and (3), where the frequency variation circuit element is means-plus-function, the obviousness discussion in ¶¶103–104 (resulting in an analog-generated triangle waveform for dithering) provides the very structure (current sources charging a capacitor to produce a ramp/sawtooth waveform) that was widely used to implement soft-start, as described in ¶¶62–70.

111. For cases (2) and (4), where the frequency variation circuit element is not means-plus-function, the TEA2262 prior-art reference anticipates Claim 4. That is because it includes the Claim 1 anticipating elements enumerated in ¶100, and in addition it uses the same soft-start signal (the ramp voltage on C_1) to vary the oscillator frequency, as shown in the datasheet's block diagram.

'851 Patent, Claim 7

112. Dependent Claim 7 adds to Claim 1 a limitation relating to the frequency modulation deviation. This claim appears to me to be indefinite, insofar as its language does not make technical sense.

113. The claim reads: "The pulse width modulated switch of claim 1 wherein said frequency of said oscillation signal varies within said frequency range with a magnitude of said frequency variation signal." However, the "magnitude of said frequency variation signal," being a voltage or a current (units of volts or amperes), cannot be a *frequency* variation, as required, because the units of the latter are neither volts nor amperes, but rather hertz (cycles per second). On this issue I am not trying to be fussy; rather, I'm baffled by the claim, whose intended meaning I cannot fathom.

114. However, if this claim is found not to be indefinite, it appears not to add limitations to Claim 1 that would affect the analysis of the latter's invalidity, in ¶¶97–104 above.

115. It might be argued that the claim was intended to require some sort of continuity, or monotonicity, in the frequency variation. Although I do not understand how such an interpretation could derive from the claim's language, I note that the patent's Figure 1 meets all the limitations of the claim. And if Figure 1 is excluded from consideration, then the LM2588 (and associated deStasi & Szepesi article) meet the claim limitations.

'851 Patent, Claim 9

116. Dependent claim 9 adds to Claim 1 a line-powered unregulated DC supply, and a transformer whose primary is powered by the DC and switched by the switch element of Claim 1.

117. This is a standard configuration for an off-line switchmode power converter. In fact, the added elements describe precisely the power converter configu-

ration of the patent's Figure 1. Thus, if the frequency variation element of Claim 1 either is not means-plus-function, or if it is and Figure 1 is included as an embodiment, then Figure 1 meets the limitations of Claim 1 (as explained in ¶¶97, 98, and 101), and therefore it meets also the limitations of Claim 9.

118. If the frequency variation element of Claim 1 is not means-plus-function, then prior art references not cited in the '851 patent that include all the elements of Claim 9 include the datasheets for the TEA2262, TK75001, and TEA1504 integrated circuits, and SGS-Thomson Application Note AN376.

119. If the frequency variation circuit element of Claim 1 is construed as a means-plus-function element, but the patent's Figure 1 is excluded as an illustrated embodiment, then the reasons stated above in ¶¶102–104 render the claim invalid for reasons of obviousness.

120. Finally, these same reasons that the claim is invalid by reason of obviousness apply regardless of whether or not the frequency variation element is finally construed to be means-plus-function.

'851 Patent, Claim 10

121. Dependent Claim 10 adds to Claim 1 the limitation that the oscillation signal's threshold is provided by a feedback signal. This would be the case, for example, if the PWM switch is used in a regulated DC/DC converter.

122. This added limitation is present in every reference cited above (in ¶¶97–104) in connection with invalidity of Claim 1, with the exception of the Ferrario patent and the Habetler article. Therefore, with those exceptions, the reasons presented in ¶¶97–104 for invalidity of Claim 1 apply also to Claim 10.

'851 Patent, Claim 11

123. Independent Claim 11 deals with subject matter similar to that of Claim 1, but differs in the preamble ("A regulation circuit comprising," rather than "A pulse width modulated switch comprising") and in the addition of a "feedback terminal" element. As with Claim 1, I understand that the parties disagree as to whether the "frequency variation circuit" element is to be interpreted as a means-plus-function element.

124. Independent Claim 11 is analogous to the '366 patent's Claim 9, in explicitly citing a "regulation circuit"; here, however, the independent claim includes frequency dither, with soft start added as a dependent claim (Claim 13).

125. The addition of the feedback terminal element ("a feedback terminal couple to disable the regulation circuit;") causes some difficulty in understanding the technical content of this claim. In particular, the preamble ("A regulation circuit comprising:") means that the seven following elements are all part of the "regulation

circuit," whereas the feedback terminal (the third element) is said to be able "to disable the regulation circuit." Read literally, it seems to say that the feedback terminal can disable the switch terminals, the switch, the frequency variation circuit, the oscillator, the drive circuit, and, evidently, it can even disable itself. One wonders if this claim can stand, on the basis of definiteness.

126. If Claim 11 is found not to be invalid, its content would appear to differ from that of Claim 10 in no way that would change the conclusions in ¶¶121–122, namely that the claim in invalid by reason of anticipation, obviousness, or both.

'851 Patent, Claim 13; '366 Patent, Claim 14

127. Dependent Claim 13 adds a soft-start circuit to the regulation circuit of independent Claim 11, and which inhibits switch drive according to the frequency variation signal. For purposes of validity analysis, it differs in no significant way from Claim 14 of the '366 patent (which adds frequency dither to the regulation circuit, with soft-start, of its Claim 9).

128. I understand that the soft start circuit element may be ruled to be a means-plus-function limitation, but if so the parties disagree as to whether Figure 1 is included in the embodiments. For Claim 11, upon which this claim depends, I understand that the parties disagree as to whether the frequency variation element is means-plus-function; and if it is, there is the same disagreement regarding Figure 1's inclusion as an illustrated embodiment.

129. If the soft-start circuit element is not means-plus-function, or if it is and Figure 1 is an included embodiment, then Figure 1 anticipates these two claims, regardless of whether the frequency variation element is means-plus-function, or is not. A reason for the examiner's allowance, apparently at odds with this conclusion, was given in ¶70.

130. If the soft-start circuit element is means-plus-function but Figure 1 is not an included embodiment, there are two cases to consider: either the frequency variation circuit element is means-plus-function, or it is not. If the latter, the analysis in ¶111 applies, namely that the TEA2262 prior-art reference anticipates these two claims.

131. In the alternative (the frequency variation element being means-plus-function, with Figure 1 excluded), the analysis in ¶110 applies, rendering these two claims obvious.

'851 Patent, Claim 16

132. Dependent Claim 16 adds to Claim 9 the limitation that five of the seven elements of Claim 9 comprise a monolithic device.[39] If Claim 9 is invalid, for any of the reasons given above, then Claim 16 is invalid for reasons of obviousness, by the

[39]The "feedback terminal" and "oscillator" elements are not included in the inven-

same reasoning as in ¶75, above.

'851 Patent, Claim 17

133. Dependent Claim 17 adds to Claim 11 the same limitations as Claim 9 added to Claim 1, namely the inclusion of a line-powered unregulated DC supply, and a transformer whose primary is powered by the DC and switched by the switch element of Claim 11. And, for the reasons in ¶¶94–104 (excluding the Ferrario, Martin, Wang, and Habetler references) and ¶¶116–120, it is invalid for reasons of anticipation, obviousness, or both.

'876 Patent, Claim 1

134. Independent Claim 1 uses a counter coupled to a DAC to control the switching frequency of an oscillator in a power supply, where the oscillator's output is coupled to the counter.

135. The following prior-art references contain all the limitations of this claim: the Martin patent; the Wang and Sanders article; and the Habetler and Divan article. They anticipate Claim 1.

136. Taking the Martin patent first, its figure shows exactly this configuration: a voltage-controlled oscillator is shown driving a counter, whose output is coupled to a DAC (via a ROM), thence to the VCO's control input. This circuit provides the oscillator for a DC-DC switching power supply. It includes all the elements of Claim 1, which it anticipates.

137. The Wang & Sanders article describes frequency variation in DC-DC switching converters. Its Figure 20 shows a configuration consisting of an oscillator whose frequency can be varied by the output of a DAC, the oscillator's output clocking a counter whose output is coupled (via a ROM) to the DAC. It includes all the elements of Claim 1, which it anticipates.

138. The Habetler & Divan article deals with switching AC power supplies. Its Figure 5 illustrates a voltage-controlled oscillator whose output clocks a counter, the output of which is coupled (via a ROM) to a DAC whose output drives the VCO's control input. It includes all the elements of Claim 1, which it anticipates.

139. Moreover, prior art that used analog dither waveforms include the Stumfall patent, the Ferrario patent, and others. One of skill in the art would have known that another way of generating analog waveforms is with a counter and DAC (e.g., the Horowitz and Robinson reference, the Tietze and Schenk reference, the Sheingold reference, or the Hardin patent). In fact, the Habetler reference (which deals with frequency dithering in power converters) illustrates, in two adjacent figures, the use of an analog waveform generator (Figure 4) and an alternative digital method with

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tory.

counter and DAC (Figure 5). With ample motivation to combine these (and other) references, the difference between the prior art and the claimed invention would have been obvious to one of skill in the art.

'876 Patent, Claim 17, 18, and 19

140. Independent Claim 17 is a method claim, comprising a primary voltage; one or more secondary voltage sources cycled to generate a secondary voltage that varies with time; and combining the primary and secondary voltages into the input of a VCO for generating a switching frequency that varies with time.

141. In looking to the specification to clarify the meaning of this claim, I cannot find any place where these voltages are shown or explained. This is in sharp distinction to the expansive explanation of the use of *current* sources, and combining of currents, to create a dithered oscillator, as illustrated in Figures 1, 3, and 6, and the discussion at 4:40–6:5.

142. The few mentions of the use of *voltages* are cryptic, and contradictory. For example, at 3:10–14, immediately following a discussion of combining currents, there appears the following: "The means for varying the frequency may include one or more voltage sources connected to the control input; and a counter connected to the output of the oscillator and to the one or more voltage sources." This sentence makes no sense, because it is an engineering fact that one cannot connect more than one voltage source to an input.

143. Based upon the above, I believe that Claim 17 is not enabled. It reaches to encompass methods it has not disclosed or taught. Dependent Claims 18 and 19 are likewise invalid.

144. In the event that Claim 17 is found not to be invalid for the reasons described in ¶¶140–143, the Habetler reference contains all the elements of Claims 17–19, to the extent that their technical meaning can be understood. Specifically, its Figure 5 shows a pair of signals, which could be voltages, being combined in a summing circuit to create the signal (which could be a voltage) that drives the VCO's frequency control input. The input labeled "average slope" would correspond to the "primary voltage" of Claim 17; the internal circuitry of the DAC would correspond to the "one or more secondary voltage sources"; and the summing circuit would correspond to the "combining" element of the claim. Claims 18 and 19 are further addressed in the attached claim charts.

Supplementation

This report represents my current opinions, based upon the materials I have reviewed.[40] If additional materials or information come to my attention, I reserve the right to revise or supplement the opinions in this report.

Paul Horowitz

Paul Horowitz
30 November 2005
Cambridge, Massachusetts

[40]This report precedes any briefings or rulings on claim construction, and also final deposition transcripts of the lead inventor of the '851, '366, and '876 patents. Additional discovery and depositions are likely to be relevant.

Curriculum Vitae — Paul Horowitz

Born: December 28, 1942

Degrees: **A.B.** (Physics) 1965, Harvard (summa cum laude)
A.M. (Physics) 1967, Harvard
Ph.D. (Physics) 1970, Harvard

Positions, fellowships & awards:

currently Professor of Physics and of Electrical Engineering, Harvard University

1965–66	Sheldon Traveling Fellowship
1966–67	NSF predoctoral fellow
1967–70	Society of Fellows, Harvard
1971–73	Alfred P. Sloan fellow
1974–	Professor of Physics, Harvard
1977	Visiting scientist, University of Colorado
1978	Visiting scientist, Arecibo Observatory
1981–82	Senior research associate, NASA Ames Research Center
1982–85	Board of editors, *Review of Scientific Instruments*
1983–	JASON study group
1985	The Year's 100 Top Innovations, *Science Digest*
2003	"Treasured Textbooks," *IEEE Spectrum*

Electronic design experience:

Over forty years of circuit design experience — more than a thousand circuits, several hundred instruments

Author (with W. Hill) of *The Art of Electronics* (Cambridge University Press, 1980, 1989), an authoritative textbook of circuit design, now in its second edition with worldwide sales of a million copies, and translations into 8 or more languages

Teacher (and originator) of "Laboratory Electronics" design course at Harvard University, widely copied at other universities and technical schools

Originator and supervisor of the Electronic Instrument Design Laboratory at Harvard

Other research interests:

optical timing experiments on the Crab Nebula pulsar
searches for new pulsars with Fourier and correlation techniques

development of synchrotron radiation facility at CEA
development of a scanning x-ray microscope
development of a scanning proton microprobe in air
studies of the e.coli rotary engine
coded-aperture spectroscope for cometary astronomy
speckle imaging
radiofrequency searches for extraterrestrial intelligence (SETI)
billion-channel digital spectrum analyzer for SETI
astronomical interferometry
search for ultraheavy matter
technologies for humanitarian demining
search for hydrogen condensations in the early universe
optical SETI

Professional memberships:

American Association for the Advancement of Science (AAAS)
Institute of Electrical and Electronics Engineers (IEEE)

Publications:

nearly 200 journal articles, book chapters, and reports on diverse topics in experimental physics and astrophysics, electronics, and national security

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Recent Publications — Paul Horowitz

The Art of Electronics, 2nd edition. with W. Hill. Cambridge University Press, 1125pp (1989).

Chapter 20, in Swift, D.W., ed., *The SETI Pioneers*. University of Arizona Press (1989).

Student Manual for *The Art of Electronics*. with T. Hayes. Cambridge University Press, 614pp (1989).

"High-Tech in a Suitcase," in Preiss, B. and Bova, B., eds., *First Contact*. New American Library, New York (1990).

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"Optical SETI at Harvard-Smithsonian." with A. Howard et al., in *Bioastronomy 99* (proc conf 2–6 Aug 99, Kona) (2000).

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"Targeted and All-Sky Search for Nanosecond Optical Pulses at Harvard-Smithsonian." with A. Howard et al. *Proc SPIE*, 119–127 (2001).

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"Targeted Optical SETI at Harvard/Smithsonian and Princeton." with J. Gallicchio et al. *Intl Acad Astronautics Intl Conf*, Bremen (2003).

"Search for Nanosecond Optical Pulses from Nearby Solar-type Stars." with A. Howard et al. *Astrophysical Journal* **613** 1270–84 (2004).

"Synchronization of the Acoustic Evidence in the Assassination of President Kennedy." with R. Linsker et al. *Science and Justice* in press (2004).

in addition, author/coauthor of 80 technical reports with restricted publication (during the period 1989–2005) on topics in national security.

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Consulting and Employment (1994–2005)
Paul Horowitz

During 1997 I testified by deposition and at trial in the case of *Security and Access v. Motorola, Inc.*[1], tried in the U.S. District Court for the District of Delaware. From July 1999 I have been serving as an expert witness[2] in several cases involving patents held by Vicor Corporation, in particular *Vicor v. Unitrode*, *Vicor v. Lucent*, *Vicor v. Power-One*, *Vicor v. Artesyn*, and *Vicor v. Lambda*. These are being tried in the U.S. District Court for the District of Massachusetts; my participation has taken the form of Expert Reports and Rebuttals, Declarations, depositions, and testimony at hearings and trial. Since September 2002 I have been serving as an expert witness in the case of *Chrimar Systems, Inc. v. Cisco Systems, Inc.*[3], being tried in the U.S. District Court for the Eastern District of Michigan, where my participation has taken the form of Expert Reports and Rebuttals, Declarations, and depositions. Since September 2003 I have been serving as an expert witness in the case of *Lectrolarm v. Vicon et al.*[4], being tried in the U.S. District Court for the Western District of Tennessee, where my participation has taken the form of Expert Reports, depositions, and testimony at hearings. These cases involve telephone and cellular handset security, electronic power conversion technologies, computer network security and powering, and remote surveillance camera technology, respectively.

Additional consulting during the last decade includes Bell, Boyd & Lloyd (on behalf of Bosch Security Systems), Bristows (on behalf of Ericsson), Cesari & Mckenna (on behalf of Gerald Pellegrini), Fish and Richardson (on behalf of Eaton Power Quality) and the Mitre Corporation (an FFRDC, on behalf of various agencies of the U.S. government). My employer has been, and continues to be, Harvard University.

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[1] on behalf of Motorola.

[2] on behalf of Vicor.

[3] on behalf of Cisco.

[4] on behalf of defendants Bosch Security Systems, GE Interlogix, Matshushita Electric, Sensormatic Electronics, Sony Electronics, and Vicon Industries.